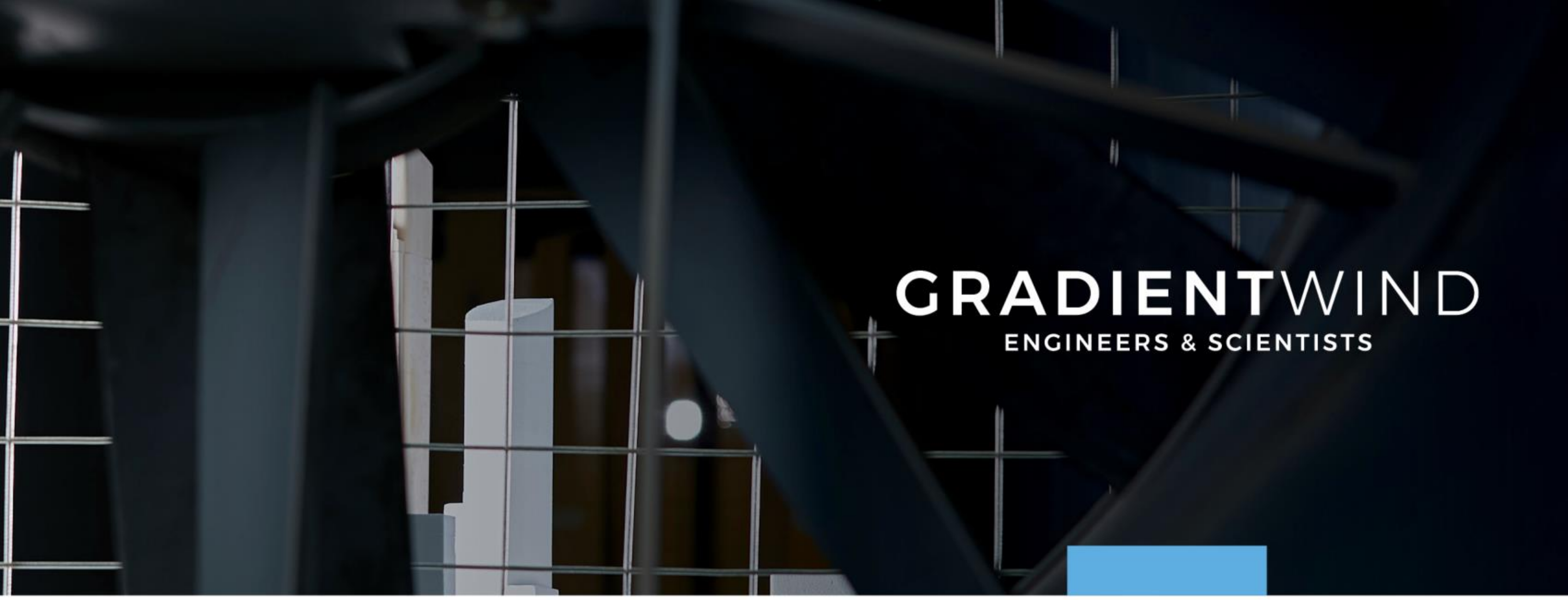
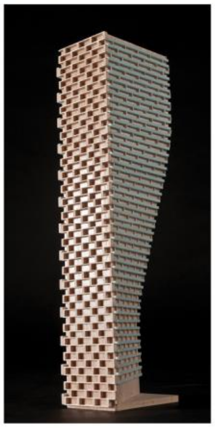
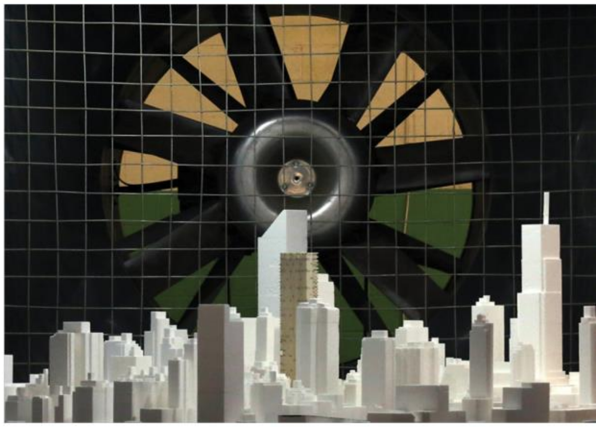


PEDESTRIAN LEVEL WIND STUDY

17/19 Ann Street and
84/90 High Street East
Mississauga, Ontario

REPORT: GWE21-145-WTPLW





December 14, 2021

PREPARED FOR
10 West GP Go Inc.
141 Lakeshore Road East
Mississauga, Ontario
L5G 1E8

PREPARED BY
Angelina Gomes, B.Eng., EIT, Junior Wind Scientist
Andrew Sliasas, M.A.Sc., P.Eng., Principal

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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EXECUTIVE SUMMARY

This report describes a comparative pedestrian level wind study undertaken to assess wind conditions for a proposed mixed-use development located at 17/19 Ann Street and 84/90 High Street East in Mississauga, Ontario. The study involves wind tunnel measurements of pedestrian wind speeds using a physical scale model, combined with meteorological data integration, to assess pedestrian comfort at key areas within and surrounding the study site. Grade-level pedestrian areas investigated include sidewalks, walkways, building access points, parking areas, future P.O.P.S. and park spaces, green space, outdoor amenity areas, plazas, patios, public parks, and nearby transit stops. Wind comfort is also evaluated over the various outdoor amenity terraces. To evaluate the influence of the proposed development on the existing wind conditions surrounding the site, two massing configurations were studied: (i) existing conditions without the proposed development, and (ii) conditions with the proposed development in place. The results and recommendations derived from these considerations are summarized in the following paragraphs and detailed in the subsequent report.

Our work is based on industry standard wind tunnel testing and data analysis procedures, City of Mississauga wind criteria, architectural drawings provided by CORE Architect Inc. in October 2021, surrounding street layouts, as well as existing and approved future building massing information and recent site imagery.

A complete summary of the predicted wind conditions is provided in Section 5.2 of this report, and is also illustrated in Figures 2A-3B, as well as Tables A1-A2 and B1-B4 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Mississauga, we conclude that conditions over most pedestrian-sensitive areas within and surrounding the development site will be acceptable for the intended pedestrian uses on an annual and seasonal basis. Exceptions include nearby transit stops along Hurontario Street and Ann Street, the primary lobby entrance, and potential grade-level outdoor amenity at the northwest corner of the building. Mitigation is recommended as described in Section 5.2.

The outdoor amenity terraces at Levels 2 and 16 will be comfortable for sitting or more sedentary activities during the summer, without the need for mitigation.

A comparison of the existing versus future wind comfort surrounding the study site indicates that the proposed development will have a generally neutral-to-negative influence on grade-level wind conditions. A portion of sidewalk along Park Street East to the west of the site and green space northeast of the site will experience a slight improvement in pedestrian comfort upon the introduction of the proposed development, while portions of surrounding sidewalk along High Street East, Hurontario Street, Park Street East, and Ann Street become somewhat windier. Where wind comfort becomes unsuitable for the intended pedestrian activity, mitigation is recommended as described in Section 5.2

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site were found to experience conditions that could be considered unsafe.

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ENGINEERS & SCIENTISTS

TABLE OF CONTENTS

1. INTRODUCTION

This report describes a pedestrian level wind study undertaken to assess wind conditions for a proposed mixed-use development located at 17/19 Ann Street and 84/90 High Street East in Mississauga, Ontario. The study was performed in accordance with industry standard wind tunnel testing techniques, City of Mississauga wind criteria, architectural drawings provided by CORE Architect Inc. in October 2021, surrounding street layouts and existing and approved future building massing information, as well as recent site imagery.

2. TERMS OF REFERENCE

The focus of this pedestrian wind study is the proposed mixed-use development located at the west corner of a parcel of land bounded by Park Street East to the northwest, Hurontario Street to the northeast, High Street East to the southeast, and Ann Street to the southwest.

The study building comprises a 22-storey stepped approximately ‘L’-shaped massing aligned longitudinally with Ann Street. Above four levels of below-grade parking, accessed from a covered driveway on the west side (referring to project north), the ground floor consists of retail space in the northeast corner with adjacent patio, indoor amenity space in the northwest corner and along the east elevation with adjacent outdoor amenities, a P.O.P.S. walkway to the south and a future public park to the east, a residential lobby along the west elevation, and residential units along the west and south elevations. The mezzanine level is largely open to below. At Level 2, the north, west, and a portion of the east elevation set back to accommodate private terraces and outdoor amenity space. Above Level 6, the floorplate steps back angularly from the south and east elevations at Levels 7, 11, and 16, accommodating private and amenity terraces. Above Level 16, the building rises with a uniform floorplate to full height, above which a mechanical penthouse completes the development.

Regarding wind exposures, the near-field surroundings of the development (defined as an area falling within a 200-metre radius of the site) consist of low- and medium-rise buildings in all directions, with future public park space proposed directly east and south of the site. The far-field surroundings (defined as the area beyond the near field and within a two-kilometer radius) are characterized as low-rise suburban buildings to the southwest clockwise to the northeast, with isolated medium- and high-rise buildings along Lakeshore Road East and West, and the open exposure of Lake Ontario dominating the northeast clockwise to the southwest.

Grade-level pedestrian areas investigated include sidewalks, walkways, building access points, parking areas, future P.O.P.S. and park spaces, green space, outdoor amenity areas, plazas, patios, public parks, and nearby transit stops. Wind comfort is also evaluated over the various outdoor amenity terraces. Figures 1A and 1B illustrate the existing and future site plan, respectively, and relevant surrounding context, and Photographs 1 through 6 depict the wind tunnel model used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind comfort and safety conditions at key areas within and surrounding the development site; (ii) identify areas where wind conditions may interfere with the intended uses of outdoor spaces; (iii) recommend suitable mitigation measures, where required; and (iv) evaluate the influence of the proposed development on the existing wind conditions surrounding the site.

4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the site is based on wind tunnel measurements of wind speeds at selected locations on a reduced-scale physical model, meteorological analysis of the Mississauga area wind climate and synthesis of wind tunnel data with industry-accepted guidelines[1]. The following sections describe the analysis procedures, including a discussion of the pedestrian comfort and safety guidelines.

4.1 Wind Tunnel Context Modelling

A detailed PLW study is performed to determine the influence of local winds at the pedestrian level for a proposed development. The physical model of the proposed development and relevant surroundings, illustrated in Photographs 1 through 6 following the main text, was constructed at a scale of 1:400. The wind tunnel model includes all existing buildings and approved future developments within a full-scale diameter of approximately 840 metres. The general concept and approach to wind tunnel modelling is to

[1] City of Mississauga Urban Design Terms of Reference, Wind Comfort and Safety Studies, June 2014

provide building and topographic detail in the immediate vicinity of the study site on the surrounding model, and to rely on a length of wind tunnel upwind of the model to develop wind properties consistent with known turbulent intensity profiles that represent the surrounding terrain.

An industry standard practice is to omit trees, vegetation, and other existing and planned landscape elements from the wind tunnel model due to the difficulty of providing accurate seasonal representation of vegetation. The omission of trees and other landscaping elements produces slightly more conservative wind speed values.

4.2 Wind Speed Measurements

The PLW study was performed by testing a total of 68 sensor locations on the scale model in Gradient Wind's wind tunnel. Of these 68 sensors, 63 were located at grade and the remaining five sensors were located over the various outdoor amenity terraces. Wind speed measurements were performed for each of the 68 sensors for 36 wind directions at 10° intervals. Figures 1A and 1B illustrate the existing and future site plan, respectively, and relevant surrounding context, while sensor locations used to investigate wind conditions are illustrated in Figures 2A through 3B.

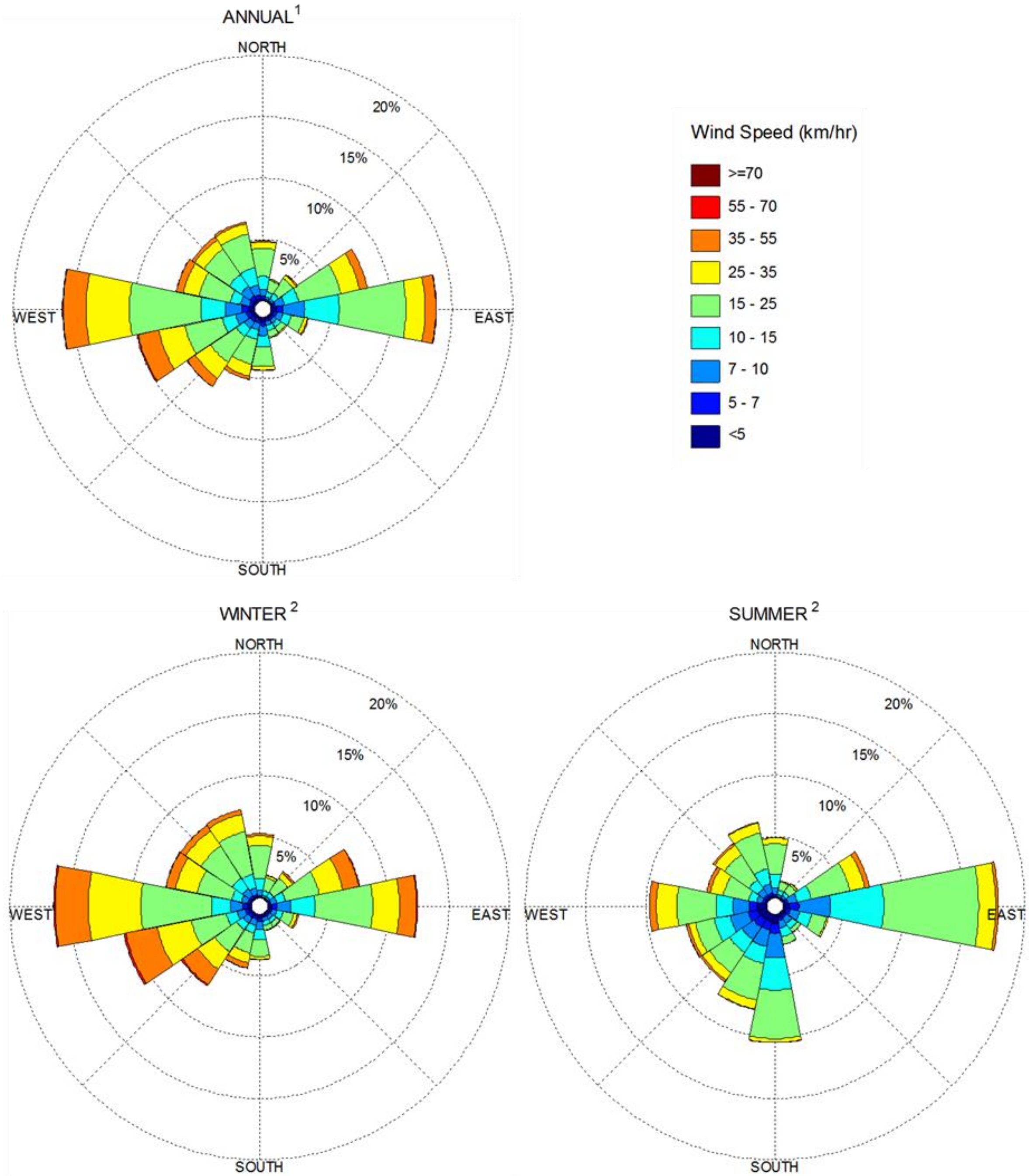
Mean and peak wind speed values for each location and wind direction were calculated from real-time pressure measurements, recorded at a sample rate of 500 samples per second, and taken over a 60-second time period. This period at model-scale corresponds approximately to one hour in full-scale, which matches the time frame of full-scale meteorological observations. Measured mean and gust wind speeds at grade were referenced to the wind speed measured near the ceiling of the wind tunnel to generate mean and peak wind speed ratios. Ceiling height in the wind tunnel represents the depth of the boundary layer of wind flowing over the earth's surface, referred to as the gradient height. Within this boundary layer, mean wind speed increases up to the gradient height and remains constant thereafter. Appendices C and D provide greater detail of the theory behind wind speed measurements. Wind tunnel measurements for this project, conducted in Gradient Wind's wind tunnel facility, meet or exceed guidelines found in the National Building Code of Canada 2010 and of 'Wind Tunnel Studies of Buildings and Structures', ASCE Manual 7 Reports on Engineering Practice No 67.

4.3 Meteorological Data Analysis

A statistical model for winds in Mississauga was developed from approximately 35-years of hourly meteorological wind data recorded at Toronto Island Billy Bishop Airport and obtained from Environment and Climate Change Canada. Wind speed and direction data were divided into two distinct seasons, as stipulated in the noted City of Mississauga Urban Design Terms of Reference. More specifically, the summer season is defined as May through October, while the winter season is defined as November through April, inclusive.

The statistical model of the Mississauga area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate seasonal distribution of measured wind speeds and directions in kilometers per hour (km/h). Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction represents the percentage of time for various wind speed ranges per wind direction during the measurement period. The preferred wind speeds and directions can be identified by the longer length of the bars. For Mississauga (south of the Queen Elizabeth Way, or QEW), the most common winds concerning pedestrian comfort during the winter season occur for westerly wind directions, followed by those from the east. The most common winds during the summer season occur for easterly wind directions. The directional preference and relative magnitude of the wind speed varies somewhat from season to season. Also, by convection in microclimate studies, wind direction refers to the wind origin (e.g., a north wind blows from north to south).

SEASONAL DISTRIBUTION OF WINDS FOR VARIOUS PROBABILITIES
TORONTO ISLAND BILLY BISHOP AIRPORT, TORONTO, ONTARIO



Notes:

1. Radial distances indicate percentage of time of wind events.
2. Wind speeds are mean hourly in km/h, measured at 10 m above the ground.

4.4 Pedestrian Comfort and Safety Guidelines

Pedestrian comfort and safety guidelines are based on the mechanical effects of wind without consideration of other meteorological conditions (i.e. temperature, relative humidity). The comfort guidelines assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Since both mean and gust wind speeds affect pedestrian comfort, their combined effect is defined in the City of Mississauga Urban Design Terms of Reference[1]. More specifically, the criteria are defined as a Gust Equivalent Mean (GEM) wind speed, which is the greater of the mean wind speed or the gust wind speed divided by 1.85. The wind speed ranges are selected based on 'The Beaufort Scale' (presented on the following page), which describes the effects of forces produced by varying wind speed levels on objects.

Four pedestrian comfort classes and corresponding GEM wind speed ranges are used to assess pedestrian comfort, which include: (i) Sitting; (ii) Standing; (iii) Walking; and (iv) Uncomfortable. More specifically, the comfort classes, wind speed ranges, and limiting criteria are summarized as follows:

(i) **Sitting** – GEM wind speeds below 10 km/h occurring more than 80% of the time would be considered acceptable for sedentary activities, including sitting.

(ii) **Standing** – GEM wind speeds below 15 km/h (i.e. 10-15 km/h) occurring more than 80% of the time are acceptable for activities such as standing, strolling or more vigorous activities.

(iii) **Walking** – GEM wind speeds below 20 km/h (i.e. 15-20 km/h) occurring more than 80% of the time are acceptable for walking or more vigorous activities.

(iv) **Uncomfortable** – Uncomfortable conditions are characterized by predicted values that fall below the 80% criterion for walking. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

Gust wind speeds greater than 90 km/h, occurring more than 0.1% of the time on an annual basis, are classified as dangerous. From calculations of stability, it can be shown that gust wind speeds of 90 km/h would be the approximate threshold wind speed that would cause a vulnerable member of the population to fall.

THE BEAUFORT SCALE

NUMBER	DESCRIPTION	WIND SPEED (KM/H)	DESCRIPTION
2	Light Breeze	4-8	Wind felt on faces
3	Gentle Breeze	8-15	Leaves and small twigs in constant motion; Wind extends light flags
4	Moderate Breeze	15-22	Wind raises dust and loose paper; Small branches are moved
5	Fresh Breeze	22-30	Small trees in leaf begin to sway
6	Strong Breeze	30-40	Large branches in motion; Whistling heard in electrical wires; Umbrellas used with difficulty
7	Moderate Gale	40-50	Whole trees in motion; Inconvenient walking against wind
8	Gale	50-60	Breaks twigs off trees; Generally impedes progress

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if GEM wind speeds of 10 km/h were exceeded for more than 20% of the time, most pedestrians would judge that location to be too windy for sitting or more sedentary activities. Similarly, if GEM wind speeds of 20 km/h at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As most of these criteria are based on subjective reactions of a population to wind forces, their application is partly based on experience and judgment.

Once the pedestrian wind speed predictions have been established across the study site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for their associated spaces. This step involves comparing the predicted comfort class to the desired comfort class, which is dictated by the location type. An overview of common pedestrian location types and their desired comfort classes are summarized on the following page.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Walking
Public Sidewalks / Pedestrian Walkways	Walking
Outdoor Amenity Spaces	Sitting / Standing
Cafés / Patios / Benches / Gardens	Sitting / Standing
Plazas	Standing / Walking
Transit Stops	Standing
Public Parks	Sitting / Walking
Garage / Service Entrances	Walking
Vehicular Drop-Off Zones	Walking
Laneways / Loading Zones	Walking

Following the comparison, the location is assigned a descriptor that indicates the suitability of the location for its intended use. The suitability descriptors are summarized as follows:

- **Acceptable**: The predicted wind conditions are suitable for the intended uses of the associated outdoor spaces without the need for mitigation.
- **Acceptable with Mitigation**: The predicted wind conditions are not acceptable for the intended use of a space; however, following the implementation of typical mitigation measures, the wind conditions are expected to satisfy the required comfort guidelines.
- **Mitigation Testing Recommended**: The effectiveness of typical mitigation measures is uncertain, and additional wind tunnel testing is recommended to explore other options and to ensure compliance with the comfort guidelines.
- **Incompatible**: The predicted wind conditions will interfere with the comfortable and/or safe use of a space and cannot be feasibly mitigated to acceptable levels.

5. RESULTS AND DISCUSSION

5.1 Pedestrian Comfort Suitability – Future Conditions

Tables A1 and A2 in Appendix A provide a summary of seasonal comfort predictions for each sensor location under the future massing scenario considering the study building and all approved surrounding developments. The tables indicate the 80% non-exceedance gust wind speeds and corresponding comfort classifications as defined in Section 4.4. In other words, a gust wind speed threshold of 12.1 for the summer season indicates that 80% of the measured data falls at or below 12.1 km/h during the summer months and conditions are therefore suitable for standing, as the 80% threshold value falls within the exceedance range of 10-15 km/h for standing. The tables include the predicted threshold values for each sensor location during each season, accompanied by the corresponding predicted comfort class (i.e. sitting, standing, walking, etc.).

The most significant findings of the PLW are summarized in the Section 5.2. To assist with understanding and interpretation, predicted conditions for the proposed development are also illustrated in colour-coded format in Figures 2A through 3B. Conditions suitable for sitting are represented by the colour green, while standing is represented by yellow, walking by blue, and uncomfortable for walking by magenta. Measured mean and gust velocity ratios, which constitutes the raw data upon which the results are based, will be made available upon request.

5.2 Summary of Findings – Future Conditions

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables A1-A2 in Appendix A, this section summarizes the most significant findings of the PLW study with respect to future conditions, as follows:

1. Most sidewalks, walkways, parking areas, and green space within and surrounding the development will experience wind conditions suitable for walking or better throughout the year. Exceptions include a portion of sidewalk west of the site along Park Street East (Sensor 24) and at the east corner of the intersection of Park Street East and Ann Street (Sensor 51), where conditions will transition to be uncomfortable for walking during the winter months. However, it is noteworthy that the walking comfort class exceedance is marginal, and pre-existing in the case

of Sensor 24, and these areas do not exceed the annual wind safety criteria; therefore, the noted wind conditions are considered acceptable for the intended uses.

2. The lobby entrance along Ann Street (Sensor 52) will be comfortable for standing during the summer and walking during the winter. To improve wind conditions for standing suitability year-round, it is recommended to either recess the entrances into the building façade or flank the doorways with vertical wind barriers.

   Potential retail entrances along the northeast corner of the building (Sensors 47-49) will be suitable for standing or better throughout the year, which is ideal.

   The private residential entrances along the south (Sensor 53) and east elevations of the building (Sensors 56-58) will be comfortable for standing or better throughout the year, which is appropriate.

   All secondary building access points (including stairwell exits and vehicle entrances) will be suitable for walking or better on a seasonal basis, which is acceptable.

3. The patio surrounding the north corner of the building (Sensors 47-49, 61, & 62) will be suitable for a mix of sitting or standing during the summer months. If calmer conditions are desired over windier portions of the patio space, a high-solidity perimeter barrier, as well as a canopy overhead, would provide adequate mitigation for seating.

4. The outdoor amenity at the east side of the building (Sensors 59-61) will be calm and suitable for sitting during the summer months, without the need for mitigation. For the outdoor amenity at the northwest corner of the building (Sensors 50 & 63), conditions will be comfortable for standing during the summer months and uncomfortable for walking on a limited basis during the colder months. If calmer conditions suitable for sitting in the summer are desired, or continued use of the space into the shoulder seasons is intended, it is recommended to install a 1.8-metre-tall barrier around the perimeter of the space comprising dense coniferous plantings, high solidity windscreens, or a combination thereof. If seating areas will be provided close to the building façade, a canopy to deflect downwash flows is recommended.

5. The P.O.P.S. walkway along the south elevation of the building (Sensors 56-58) will be comfortable for sitting or standing throughout the year, which is appropriate.

6. The future public park directly northeast of the site (Sensors 40, 42, & 44) will be suitable for standing or better during the summer and walking or better during the winter, which is appropriate.

   For the future park space to the south (Sensors 34, 35, & 37), conditions will be comfortable for sitting during the summer and for standing during the winter.

7. Regarding nearby transit stops, the one on the northeast side of Hurontario Street northeast of the development (Sensor 11) will be comfortable for sitting during the summer and standing during the winter, which is ideal. However, the opposing transit stop on the southwest side of Hurontario Street (Sensor 43) will experience walking conditions during the winter. Additionally, the transit stop along Ann Steet directly west of the development (Sensor 51) will experience conditions uncomfortable for walking during the winter, however it is notable that this stop currently exceeds the standing criterion. To achieve the recommended standing conditions throughout the year at transit stops, it is recommended to install a three-walled pedestrian transit shelter at the windier locations.

8. The nearby plaza east of the development (Sensor 10) will be suitable for standing or better throughout the year, which is unchanged from existing conditions.

9. The outdoor amenity terraces on Levels 2 and 16 (Sensors 64-68) will be comfortable for sitting throughout the summer months, without the need for mitigation.

10. Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site were found to experience wind conditions that are considered unsafe.

5.3 Pedestrian Comfort Suitability – Existing Versus Future Conditions

To evaluate the influence of the study building on existing wind conditions at and near the study site, an additional pedestrian level wind test was performed for the existing site massing without the study building present. A comparison of wind comfort results for the existing and future configurations is provided in Tables B1 to B4 in Appendix B, which provide a seasonal summary of the comparative wind comfort predictions. The future and existing massing scenarios are shown in Photographs 1 through 6 following the main text.

Pedestrian wind comfort resulting from the construction of the study building and future surrounding developments may be described as being *unchanged*, *improved*, or *reduced* as compared to the existing conditions. These designations are not strictly determined by the predicted percentage values, rather by the change to the predicted comfort class.

A review of Tables B1 to B4 indicates that wind speeds at many grade-level areas will remain unchanged upon the introduction of the proposed study building, with improvements over green space northeast of the site (Sensor 12) and a portion of the Park Street East sidewalk to the west (Sensor 25). Wind speeds increase on surrounding portions of sidewalk along High Street East (Sensors 6, 36, & 38), Hurontario Street (Sensors 9, 39, 41, 43, & 45), Park Street East (Sensors 16, 17, 19, & 49-51), and Ann Street (Sensors 30, 52, 53, & 55). Where wind comfort becomes unsuitable for the intended pedestrian activity, mitigation is recommended as described in Section 5.2.

6. CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the methodology, results, and recommendations related to a pedestrian level wind study for the proposed mixed-use development located at 17/19 Ann Street and 84/90 High Street East in Mississauga, Ontario. The study was performed in accordance with industry standard wind tunnel testing and data analysis procedures.

A complete summary of the predicted wind conditions is provided in Section 5.2 of this report, and is also illustrated in Figures 2A-3B, as well as Tables A1-A2 and B1-B4 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Mississauga, we conclude that conditions over most pedestrian-sensitive areas within and surrounding the development site will be acceptable for the intended pedestrian uses on an annual and seasonal basis. Exceptions include nearby transit stops along Hurontario Street and Ann Street, the primary lobby entrance, and potential grade-level outdoor amenity at the northwest corner of the building. Mitigation is recommended as described in Section 5.2.

The outdoor amenity terraces at Levels 2 and 16 will be comfortable for sitting or more sedentary activities during the summer, without the need for mitigation.

A comparison of the existing versus future wind comfort surrounding the study site indicates that the proposed development will have a generally neutral-to-negative influence on grade-level wind conditions. A portion of sidewalk along Park Street East to the west of the site and green space northeast of the site will experience a slight improvement in pedestrian comfort upon the introduction of the proposed development, while portions of surrounding sidewalk along High Street East, Hurontario Street, Park Street East, and Ann Street become somewhat windier. Where wind comfort becomes unsuitable for the intended pedestrian activity, mitigation is recommended as described in Section 5.2

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site were found to experience conditions that could be considered unsafe.

This concludes our pedestrian level wind study and report. Please advise the undersigned of any questions or comments.

Sincerely,

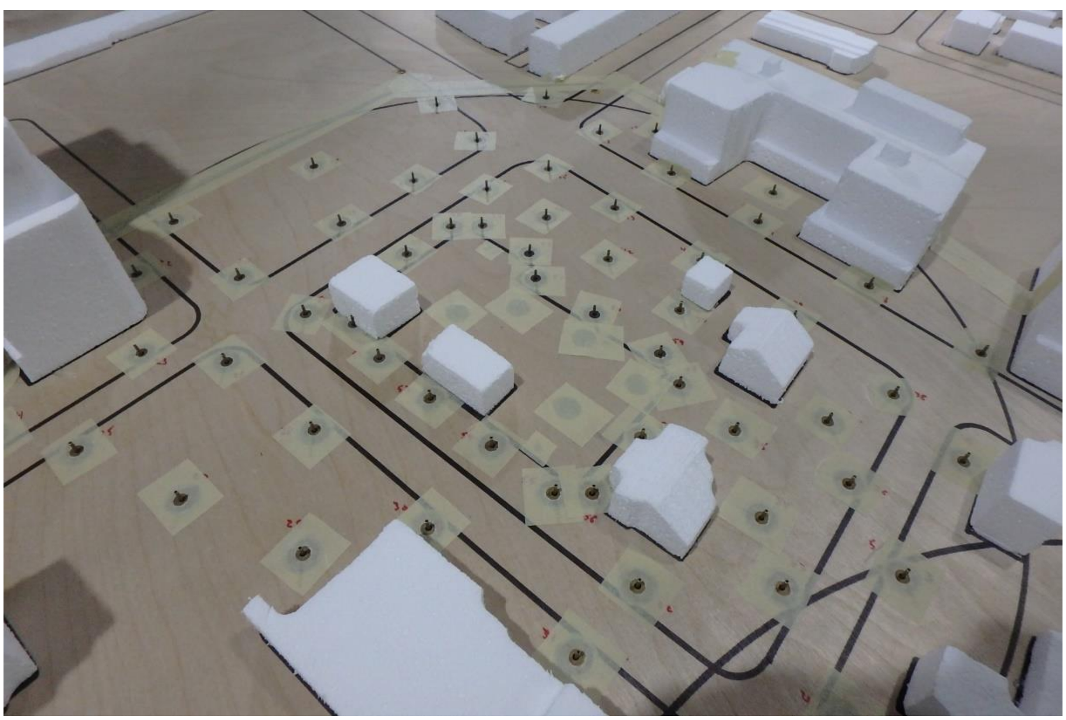
Gradient Wind Engineering Inc.

Angelina Gomes, B.Eng., EIT
Junior Wind Scientist

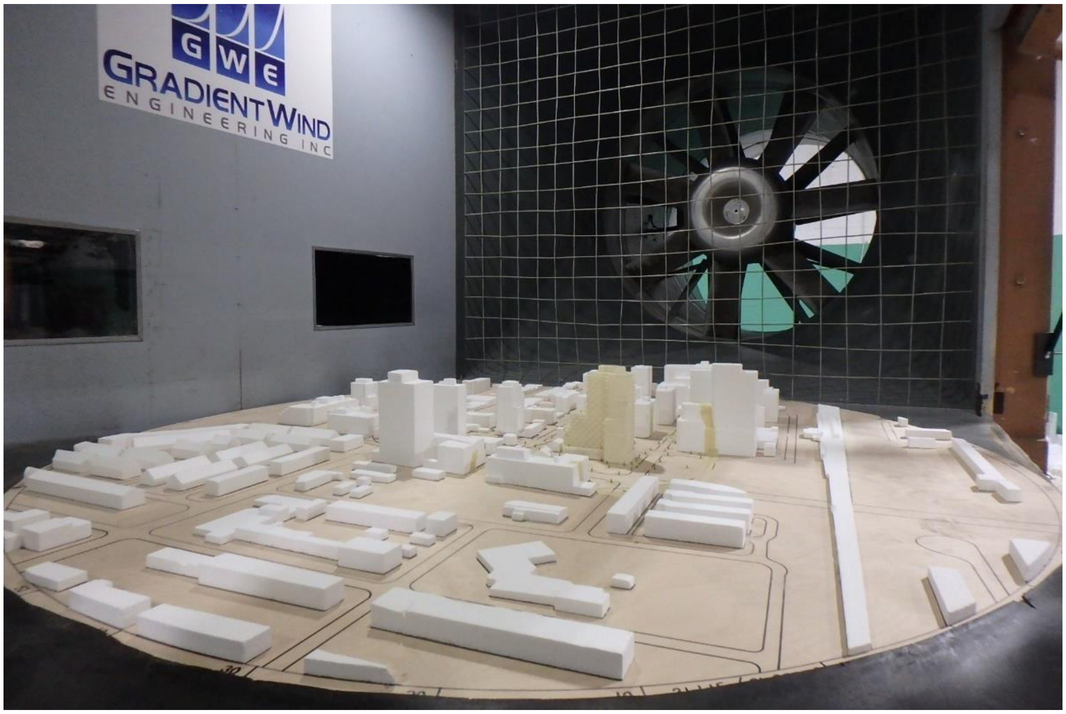
Andrew Sliasas, M.A.Sc., P.Eng.
Principal

GWE21-145-WTPLW

PHOTOGRAPH 1: CLOSE-UP VIEW OF EXISTING CONTEXT MODEL LOOKING SOUTH



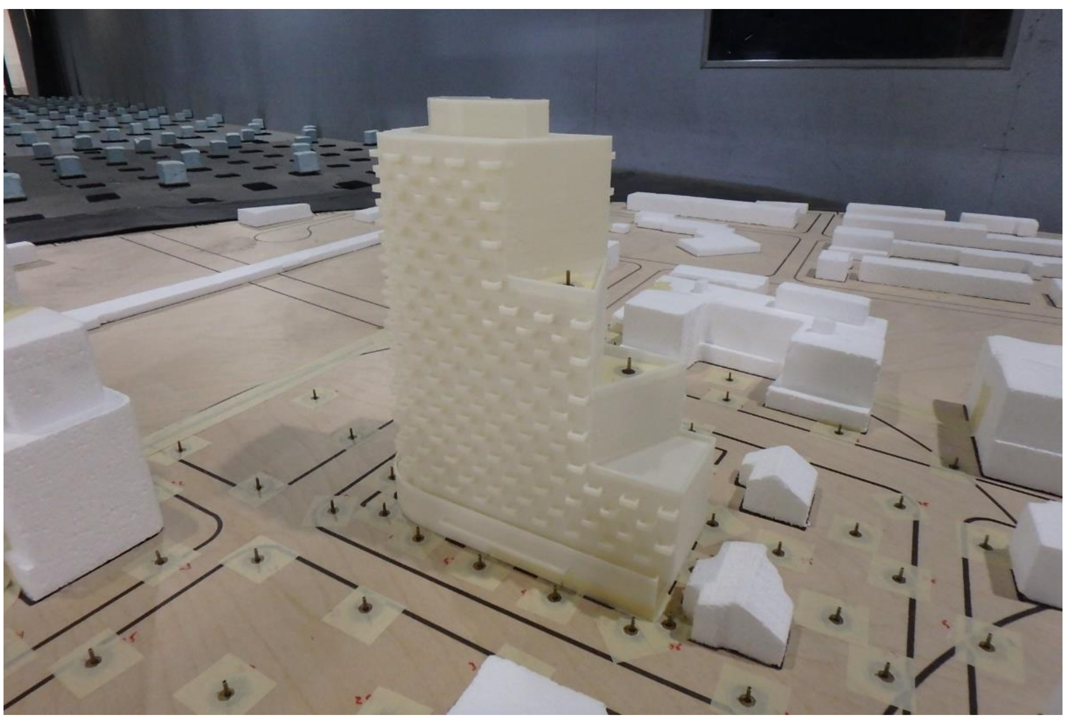
PHOTOGRAPH 2: CLOSE-UP VIEW OF EXISTING CONTEXT MODEL LOOKING NORTH



PHOTOGRAPH 3: STUDY MODEL INSIDE THE GWE WIND TUNNEL LOOKING DOWNWIND

PHOTOGRAPH 4: STUDY MODEL INSIDE THE GWE WIND TUNNEL LOOKING UPWIND

PHOTOGRAPH 5: CLOSE-UP VIEW OF STUDY MODEL LOOKING WEST



PHOTOGRAPH 6: CLOSE-UP VIEW OF STUDY MODEL LOOKING NORTH

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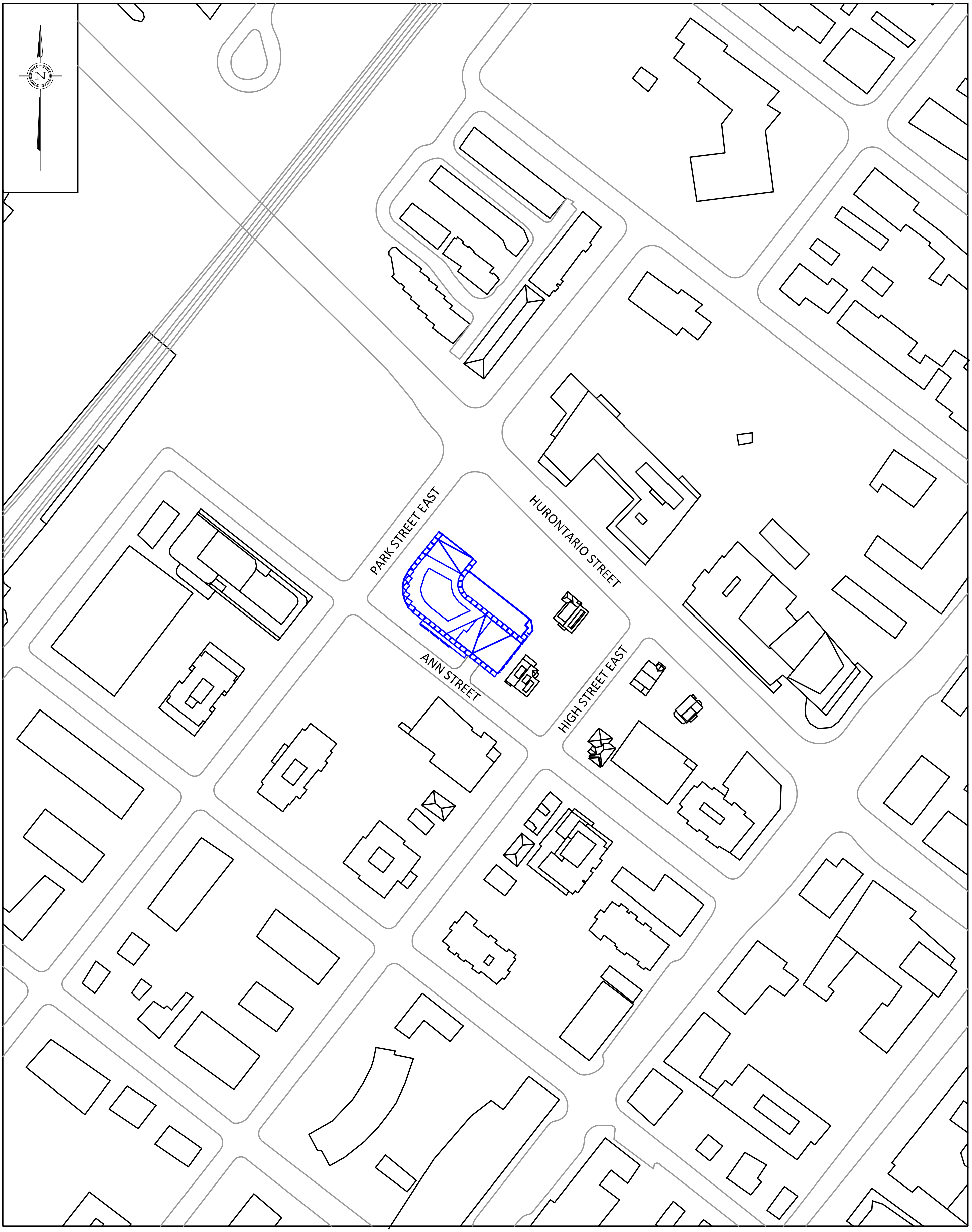
PROJECT	ANNE STREET & HIGH STREET EAST, MISSISSAUGA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:2500 (APPROX.)
DRAWING NO.	GW21-145-PLW-1A
DATE	DECEMBER 14, 2021
DRAWN BY	K.A.
DESCRIPTION	FIGURE 1A: EXISTING CONDITIONS SITE PLAN AND SURROUNDING CONTEXT



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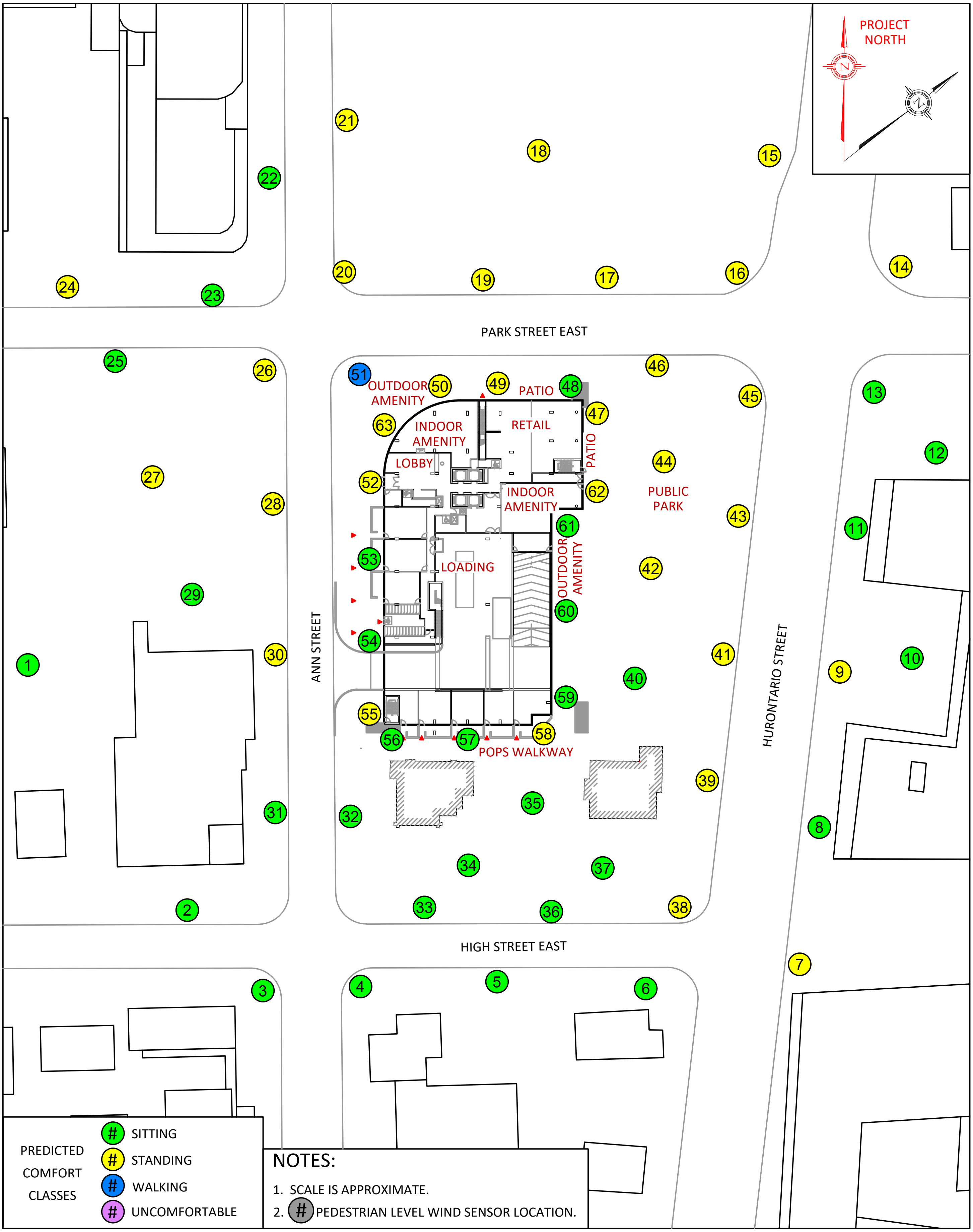
PROJECT	ANNE STREET & HIGH STREET EAST, MISSISSAUGA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:2500 (APPROX.)
DRAWING NO.	GW21-145-PLW-1B
DATE	DECEMBER 14, 2021
DRAWN BY	K.A.
DESCRIPTION	FIGURE 1B: FUTURE PROPOSED CONDITIONS SITE PLAN AND SURROUNDING CONTEXT



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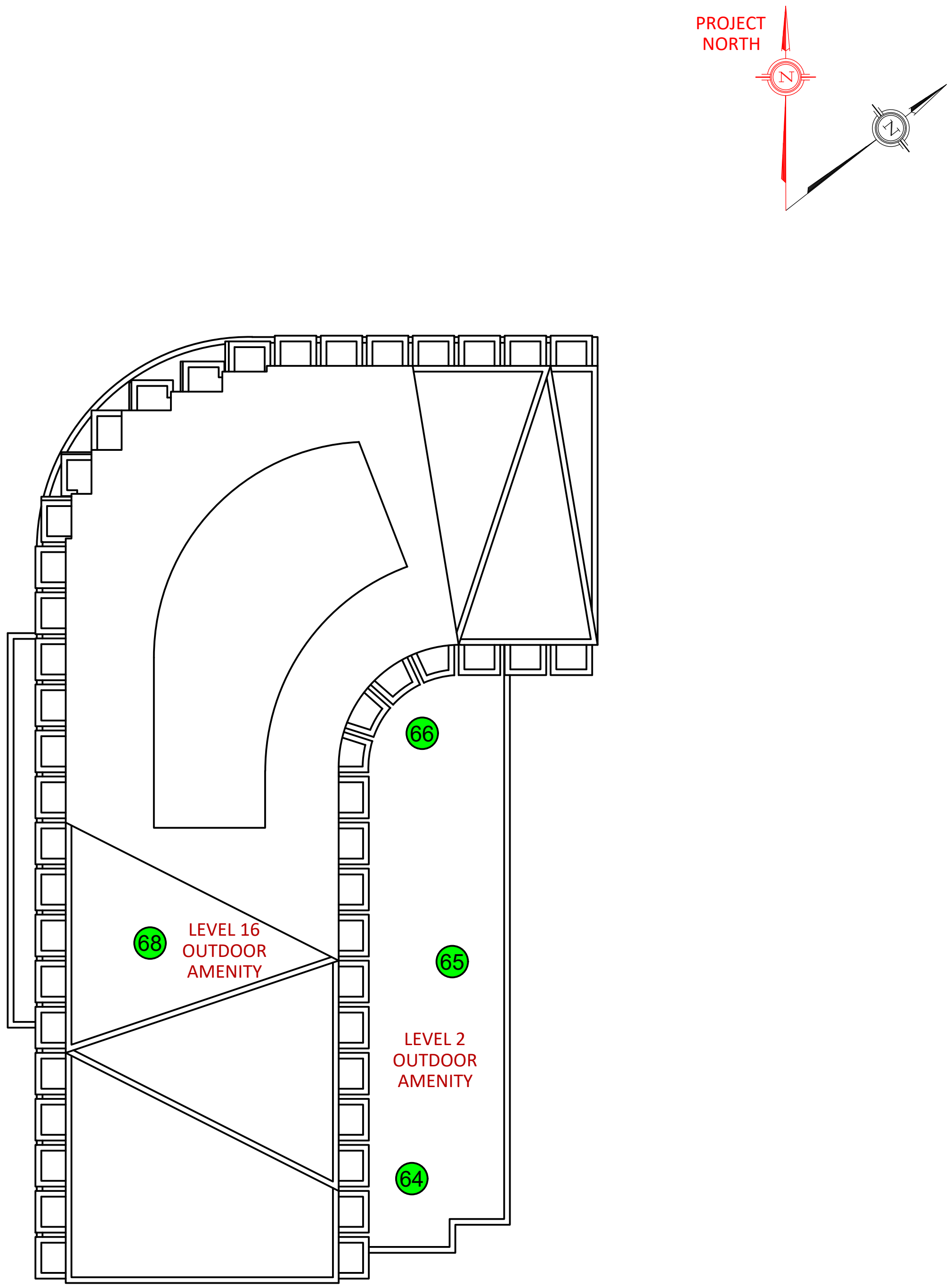
PROJECT: ANNE STREET & HIGH STREET EAST, MISSISSAUGA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 2A: SUMMER GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS
SCALE: 1:1000 (APPROX.)	DRAWING NO.: GW21-145-PLW-2A	
DATE: DECEMBER 14, 2021	DRAWN BY: K.A.	



PREDICTED COMFORT CLASSES

- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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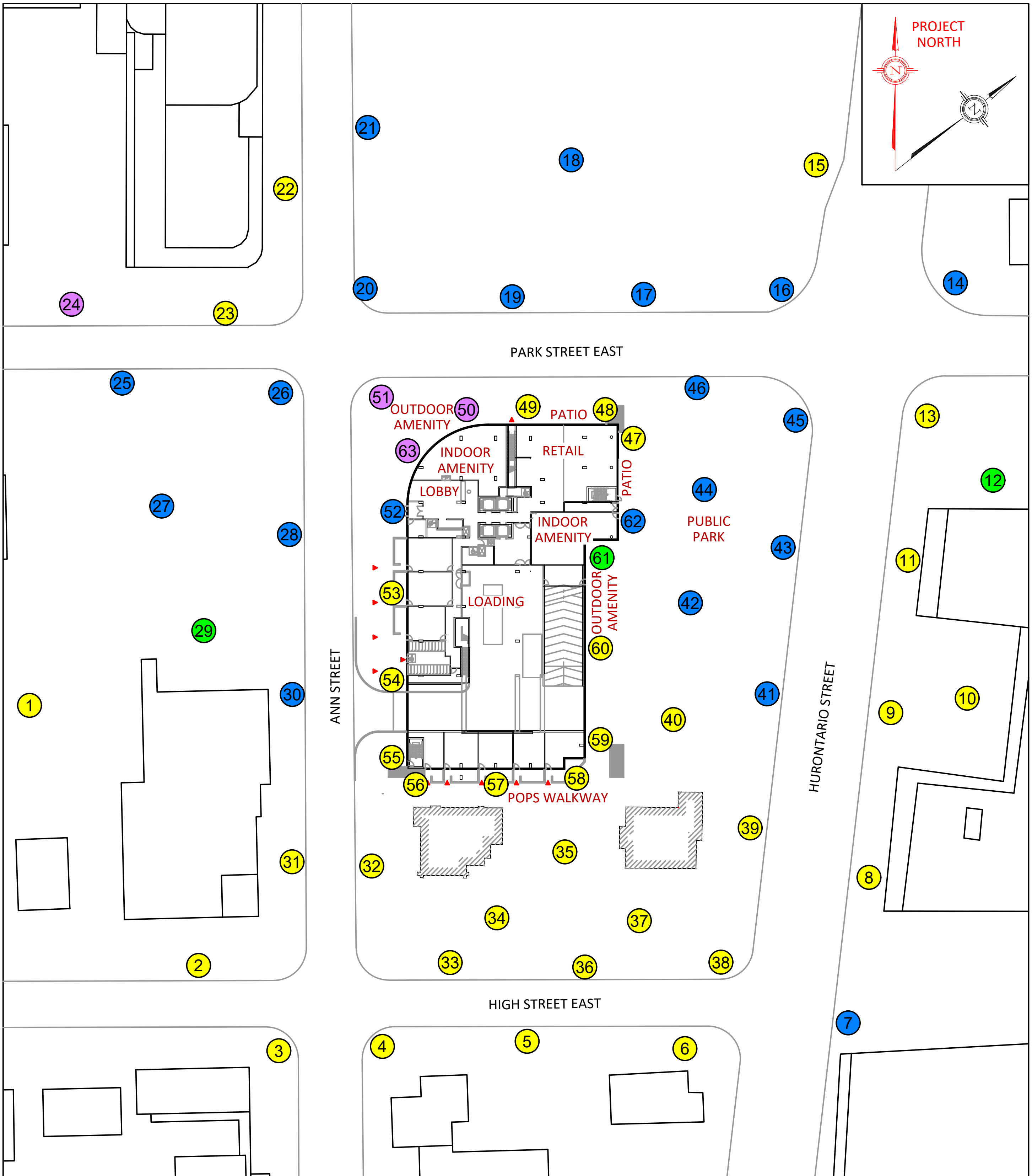
PROJECT	ANNE STREET & HIGH STREET EAST, MISSISSAUGA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:500 (APPROX.)	DRAWING NO.	GW21-145-PLW-2B
DATE	DECEMBER 14, 2021	DRAWN BY	K.A.

DESCRIPTION

FIGURE 2B: SUMMER
OUTDOOR AMENITY TERRACES
PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES

- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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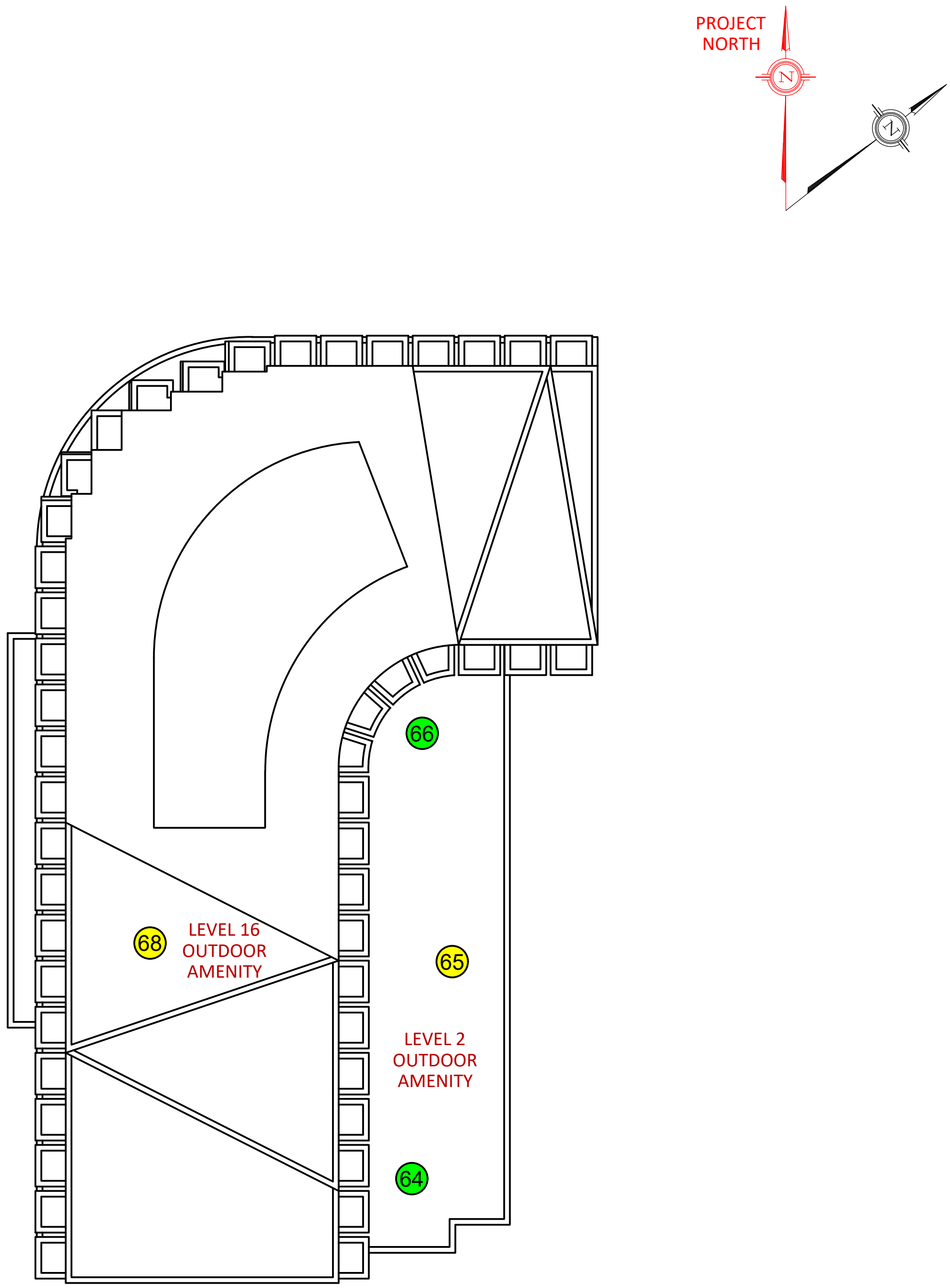
PROJECT	ANNE STREET & HIGH STREET EAST, MISSISSAUGA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW21-145-PLW-3A
DATE	DECEMBER 14, 2021	DRAWN BY	K.A.

DESCRIPTION

FIGURE 3A: WINTER
GROUND FLOOR PLAN
PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES

- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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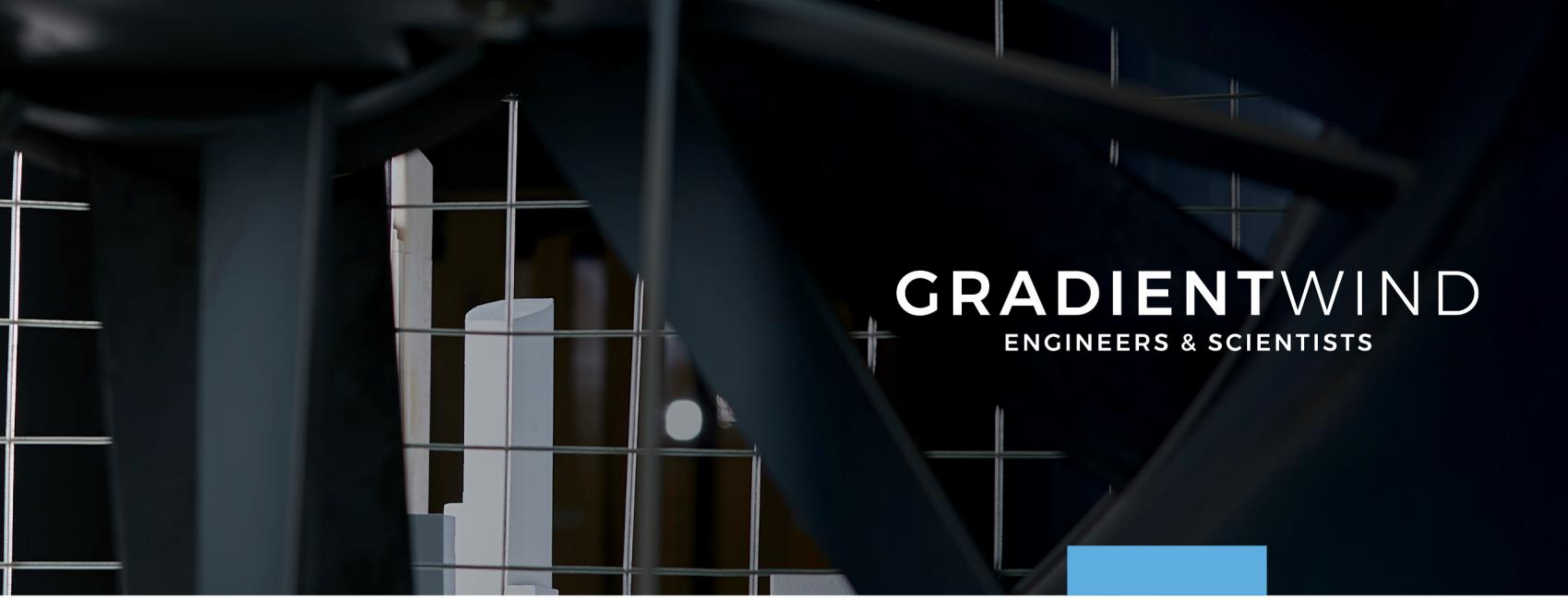
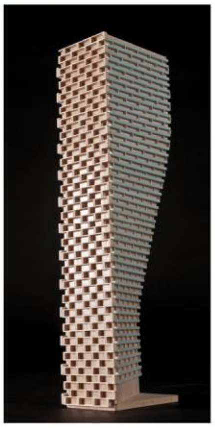
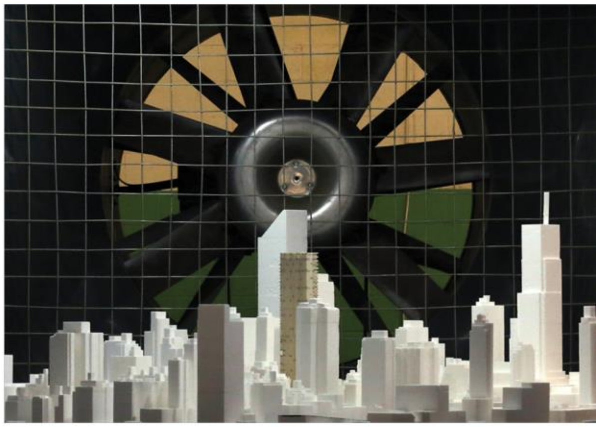
SCALE	1:500 (APPROX.)
DRAWING NO.	GW21-145-PLW-3B
DATE	DECEMBER 14, 2021
DRAWN BY	K.A.
DESCRIPTION	FIGURE 3B: WINTER OUTDOOR AMENITY TERRACES PEDESTRIAN COMFORT PREDICTIONS







APPENDIX A

PEDESTRIAN COMFORT SUITABILITY, TABLES A1-A2
(FUTURE CONDITIONS)

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Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

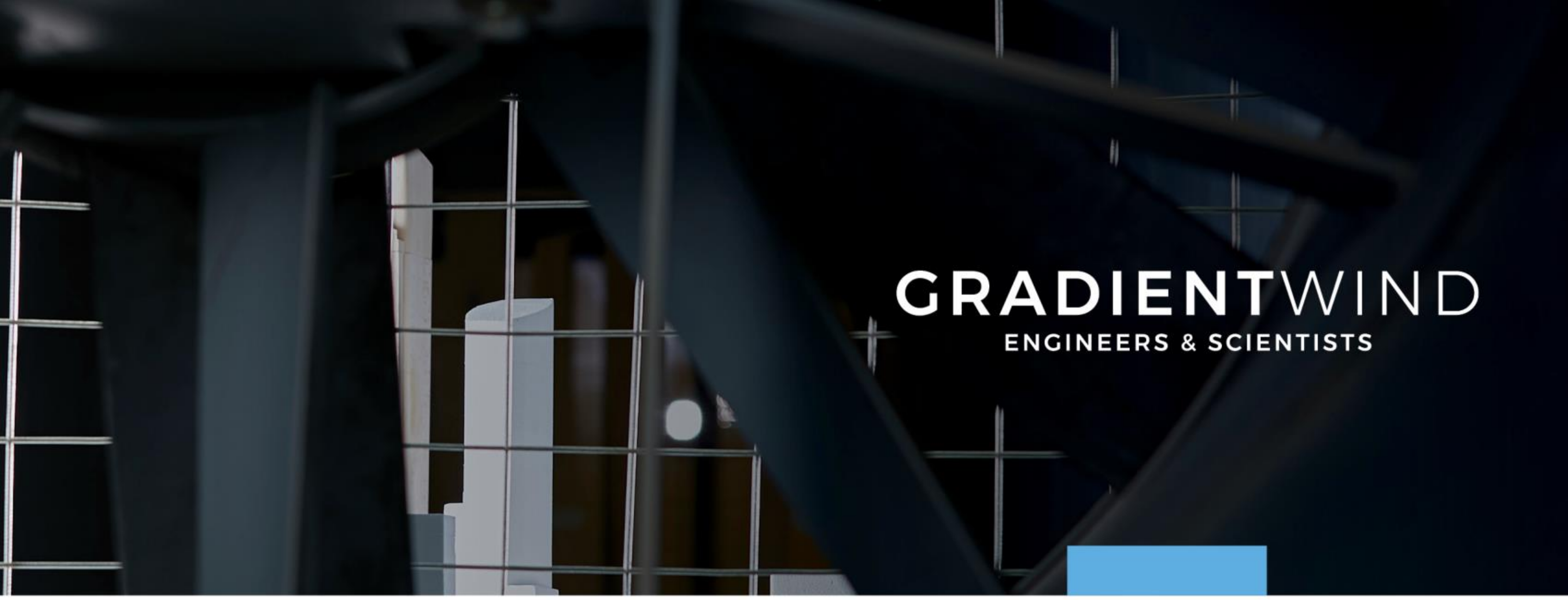
TABLE A1: SUMMARY OF PEDESTRIAN COMFORT (FUTURE CONDITIONS)

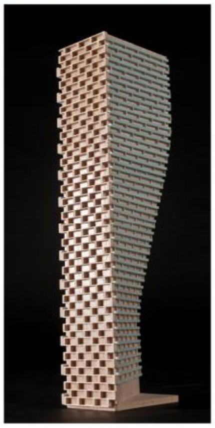
Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	9.0	Sitting	13.3	Standing	51.4	Safe
2	8.0	Sitting	10.2	Standing	40.1	Safe
3	9.2	Sitting	12.0	Standing	46.2	Safe
4	9.2	Sitting	12.9	Standing	51.9	Safe
5	8.5	Sitting	12.3	Standing	43.9	Safe
6	7.4	Sitting	10.3	Standing	38.0	Safe
7	12.4	Standing	16.3	Walking	56.0	Safe
8	7.4	Sitting	11.0	Standing	49.6	Safe
9	11.0	Standing	15.0	Standing	52.6	Safe
10	7.8	Sitting	10.7	Standing	37.2	Safe
11	8.9	Sitting	11.9	Standing	41.8	Safe
12	6.1	Sitting	9.9	Sitting	43.3	Safe
13	9.4	Sitting	12.9	Standing	46.9	Safe
14	11.0	Standing	16.4	Walking	53.1	Safe
15	10.3	Standing	15.0	Standing	55.0	Safe
16	11.4	Standing	17.0	Walking	61.8	Safe
17	11.1	Standing	15.4	Walking	59.9	Safe
18	11.6	Standing	16.5	Walking	62.6	Safe
19	11.4	Standing	15.3	Walking	57.5	Safe
20	13.7	Standing	18.4	Walking	59.0	Safe
21	10.8	Standing	15.3	Walking	56.1	Safe
22	9.3	Sitting	13.1	Standing	51.6	Safe
23	8.9	Sitting	12.8	Standing	56.5	Safe
24	12.2	Standing	20.9	Uncomfortable	71.9	Safe
25	10.0	Sitting	16.2	Walking	60.5	Safe
26	13.3	Standing	20.0	Walking	66.0	Safe
27	11.0	Standing	17.6	Walking	65.0	Safe
28	13.4	Standing	19.0	Walking	62.3	Safe
29	7.0	Sitting	9.8	Sitting	37.1	Safe
30	13.3	Standing	18.6	Walking	68.1	Safe
31	8.0	Sitting	11.4	Standing	46.2	Safe
32	9.1	Sitting	13.0	Standing	48.0	Safe
33	9.7	Sitting	13.1	Standing	47.6	Safe
34	9.2	Sitting	12.4	Standing	46.5	Safe
35	9.3	Sitting	12.9	Standing	56.4	Safe

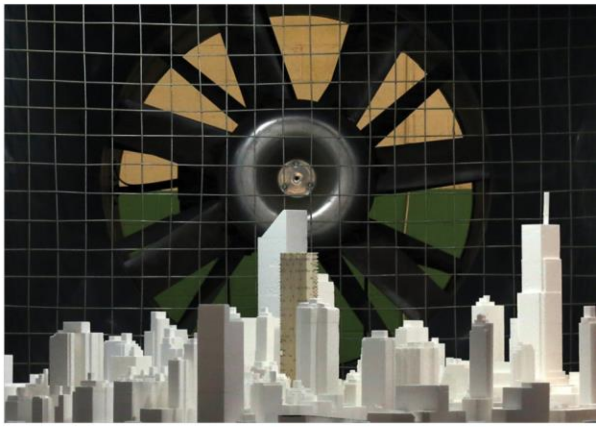
Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE A2: SUMMARY OF PEDESTRIAN COMFORT (FUTURE CONDITONS)

Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	8.2	Sitting	11.3	Standing	42.5	Safe
37	8.4	Sitting	11.0	Standing	40.5	Safe
38	10.5	Standing	14.0	Standing	51.2	Safe
39	10.4	Standing	14.6	Standing	53.3	Safe
40	10.0	Sitting	13.1	Standing	51.9	Safe
41	12.1	Standing	16.7	Walking	59.0	Safe
42	11.6	Standing	15.6	Walking	56.9	Safe
43	12.9	Standing	18.2	Walking	64.1	Safe
44	12.1	Standing	17.6	Walking	64.5	Safe
45	12.1	Standing	17.1	Walking	60.3	Safe
46	12.5	Standing	18.3	Walking	59.0	Safe
47	10.6	Standing	14.4	Standing	62.6	Safe
48	8.3	Sitting	12.3	Standing	48.9	Safe
49	10.3	Standing	14.3	Standing	51.2	Safe
50	14.3	Standing	20.1	Uncomfortable	65.3	Safe
51	15.1	Walking	21.7	Uncomfortable	63.6	Safe
52	12.9	Standing	18.6	Walking	70.7	Safe
53	9.4	Sitting	14.0	Standing	62.2	Safe
54	7.9	Sitting	11.6	Standing	45.1	Safe
55	10.9	Standing	15.0	Standing	59.0	Safe
56	9.0	Sitting	12.5	Standing	52.0	Safe
57	8.2	Sitting	10.8	Standing	47.3	Safe
58	10.5	Standing	13.1	Standing	56.0	Safe
59	9.9	Sitting	12.8	Standing	53.9	Safe
60	8.3	Sitting	11.2	Standing	54.0	Safe
61	7.2	Sitting	9.5	Sitting	52.5	Safe
62	11.9	Standing	15.7	Walking	66.4	Safe
63	15.0	Standing	21.9	Uncomfortable	72.5	Safe
64	5.2	Sitting	7.1	Sitting	24.4	Safe
65	7.4	Sitting	10.5	Standing	39.0	Safe
66	7.2	Sitting	9.8	Sitting	43.0	Safe
68	8.8	Sitting	10.5	Standing	55.4	Safe







APPENDIX B

PEDESTRIAN COMFORT SUITABILITY, TABLES B1-B4 (EXISTING VS FUTURE CONDITIONS)

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Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B1: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
1	Existing	8.2	Sitting	-	12.3	Standing	-
	Future	9.0	Sitting	Unchanged	13.3	Standing	Unchanged
2	Existing	8.0	Sitting	-	10.5	Standing	-
	Future	8.0	Sitting	Unchanged	10.2	Standing	Unchanged
3	Existing	8.6	Sitting	-	11.3	Standing	-
	Future	9.2	Sitting	Unchanged	12.0	Standing	Unchanged
4	Existing	8.3	Sitting	-	11.6	Standing	-
	Future	9.2	Sitting	Unchanged	12.9	Standing	Unchanged
5	Existing	7.5	Sitting	-	10.6	Standing	-
	Future	8.5	Sitting	Unchanged	12.3	Standing	Unchanged
6	Existing	7.1	Sitting	-	10.0	Sitting	-
	Future	7.4	Sitting	Unchanged	10.3	Standing	Reduced
7	Existing	11.6	Standing	-	15.6	Walking	-
	Future	12.4	Standing	Unchanged	16.3	Walking	Unchanged
8	Existing	6.8	Sitting	-	10.7	Standing	-
	Future	7.4	Sitting	Unchanged	11.0	Standing	Unchanged
9	Existing	9.5	Sitting	-	13.0	Standing	-
	Future	11.0	Standing	Reduced	15.0	Standing	Unchanged
10	Existing	7.3	Sitting	-	10.3	Standing	-
	Future	7.8	Sitting	Unchanged	10.7	Standing	Unchanged
11	Existing	7.3	Sitting	-	10.0	Standing	-
	Future	8.9	Sitting	Unchanged	11.9	Standing	Unchanged
12	Existing	6.9	Sitting	-	10.2	Standing	-
	Future	6.1	Sitting	Unchanged	9.9	Sitting	Improved
13	Existing	8.7	Sitting	-	11.5	Standing	-
	Future	9.4	Sitting	Unchanged	12.9	Standing	Unchanged
14	Existing	10.6	Standing	-	16.1	Walking	-
	Future	11.0	Standing	Unchanged	16.4	Walking	Unchanged
15	Existing	10.0	Standing	-	15.0	Standing	-
	Future	10.3	Standing	Unchanged	15.0	Standing	Unchanged

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B2: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
16	Existing	10.0	Sitting	-	15.0	Standing	-
	Future	11.4	Standing	Reduced	17.0	Walking	Reduced
17	Existing	10.1	Standing	-	14.7	Standing	-
	Future	11.1	Standing	Unchanged	15.4	Walking	Reduced
18	Existing	11.3	Standing	-	17.2	Walking	-
	Future	11.6	Standing	Unchanged	16.5	Walking	Unchanged
19	Existing	10.7	Standing	-	14.9	Standing	-
	Future	11.4	Standing	Unchanged	15.3	Walking	Reduced
20	Existing	12.2	Standing	-	16.8	Walking	-
	Future	13.7	Standing	Unchanged	18.4	Walking	Unchanged
21	Existing	11.0	Standing	-	15.8	Walking	-
	Future	10.8	Standing	Unchanged	15.3	Walking	Unchanged
22	Existing	8.5	Sitting	-	12.1	Standing	-
	Future	9.3	Sitting	Unchanged	13.1	Standing	Unchanged
23	Existing	8.5	Sitting	-	12.0	Standing	-
	Future	8.9	Sitting	Unchanged	12.8	Standing	Unchanged
24	Existing	13.2	Standing	-	22.1	Uncomfortable	-
	Future	12.2	Standing	Unchanged	20.9	Uncomfortable	Unchanged
25	Existing	11.8	Standing	-	18.8	Walking	-
	Future	10.0	Sitting	Improved	16.2	Walking	Unchanged
26	Existing	12.0	Standing	-	17.9	Walking	-
	Future	13.3	Standing	Unchanged	20.0	Walking	Unchanged
27	Existing	10.3	Standing	-	17.4	Walking	-
	Future	11.0	Standing	Unchanged	17.6	Walking	Unchanged
28	Existing	10.4	Standing	-	15.8	Walking	-
	Future	13.4	Standing	Unchanged	19.0	Walking	Unchanged
29	Existing	6.4	Sitting	-	9.0	Sitting	-
	Future	7.0	Sitting	Unchanged	9.8	Sitting	Unchanged
30	Existing	7.5	Sitting	-	10.5	Standing	-
	Future	13.3	Standing	Reduced	18.6	Walking	Reduced

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

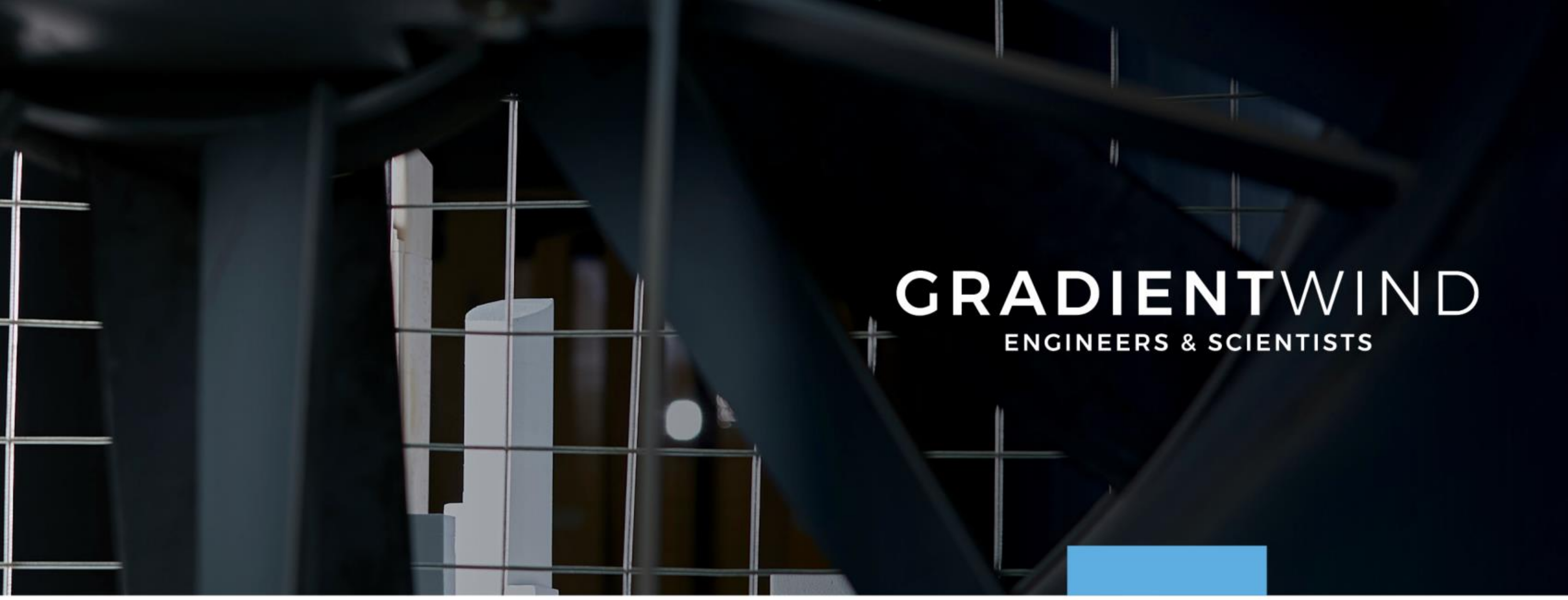
TABLE B3: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

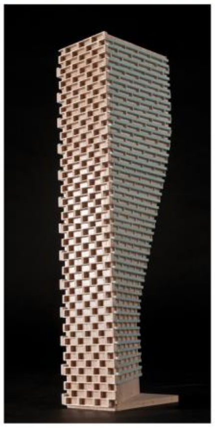
Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
31	Existing	8.2	Sitting	-	11.2	Standing	-
	Future	8.0	Sitting	Unchanged	11.4	Standing	Unchanged
32	Existing	8.7	Sitting	-	11.2	Standing	-
	Future	9.1	Sitting	Unchanged	13.0	Standing	Unchanged
33	Existing	8.0	Sitting	-	10.9	Standing	-
	Future	9.7	Sitting	Unchanged	13.1	Standing	Unchanged
34	Existing	8.3	Sitting	-	11.6	Standing	-
	Future	9.2	Sitting	Unchanged	12.4	Standing	Unchanged
35	Existing	8.7	Sitting	-	12.4	Standing	-
	Future	9.3	Sitting	Unchanged	12.9	Standing	Unchanged
36	Existing	7.0	Sitting	-	9.8	Sitting	-
	Future	8.2	Sitting	Unchanged	11.3	Standing	Reduced
37	Existing	7.1	Sitting	-	9.7	Sitting	-
	Future	8.4	Sitting	Unchanged	11.0	Standing	Reduced
38	Existing	8.9	Sitting	-	11.5	Standing	-
	Future	10.5	Standing	Reduced	14.0	Standing	Unchanged
39	Existing	8.6	Sitting	-	11.6	Standing	-
	Future	10.4	Standing	Reduced	14.6	Standing	Unchanged
40	Existing	7.5	Sitting	-	11.2	Standing	-
	Future	10.0	Sitting	Unchanged	13.1	Standing	Unchanged
41	Existing	7.8	Sitting	-	11.4	Standing	-
	Future	12.1	Standing	Reduced	16.7	Walking	Reduced
42	Existing	7.6	Sitting	-	10.7	Standing	-
	Future	11.6	Standing	Reduced	15.6	Walking	Reduced
43	Existing	9.4	Sitting	-	13.6	Standing	-
	Future	12.9	Standing	Reduced	18.2	Walking	Reduced
44	Existing	9.4	Sitting	-	13.8	Standing	-
	Future	12.1	Standing	Reduced	17.6	Walking	Reduced
45	Existing	10.1	Standing	-	14.4	Standing	-
	Future	12.1	Standing	Unchanged	17.1	Walking	Reduced
46	Existing	10.4	Standing	-	15.5	Walking	-
	Future	12.5	Standing	Unchanged	18.3	Walking	Unchanged

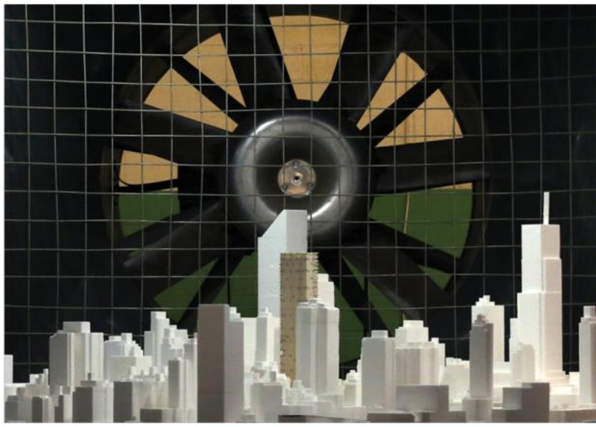
Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B4: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
47	Existing	9.5	Sitting	-	14.2	Standing	-
	Future	10.6	Standing	Reduced	14.4	Standing	Unchanged
48	Existing	9.5	Sitting	-	14.4	Standing	-
	Future	8.3	Sitting	Unchanged	12.3	Standing	Unchanged
49	Existing	9.2	Sitting	-	13.4	Standing	-
	Future	10.3	Standing	Reduced	14.3	Standing	Unchanged
50	Existing	7.8	Sitting	-	11.6	Standing	-
	Future	14.3	Standing	Reduced	20.1	Uncomfortable	Reduced
51	Existing	11.7	Standing	-	17.5	Walking	-
	Future	15.1	Walking	Reduced	21.7	Uncomfortable	Reduced
52	Existing	8.9	Sitting	-	13.3	Standing	-
	Future	12.9	Standing	Reduced	18.6	Walking	Reduced
53	Existing	6.6	Sitting	-	9.9	Sitting	-
	Future	9.4	Sitting	Unchanged	14.0	Standing	Reduced
54	Existing	7.2	Sitting	-	10.3	Standing	-
	Future	7.9	Sitting	Unchanged	11.6	Standing	Unchanged
55	Existing	7.8	Sitting	-	10.9	Standing	-
	Future	10.9	Standing	Reduced	15.0	Standing	Reduced
56	Existing	7.8	Sitting	-	11.0	Standing	-
	Future	9.0	Sitting	Unchanged	12.5	Standing	Unchanged
57	Existing	7.4	Sitting	-	10.4	Standing	-
	Future	8.2	Sitting	Unchanged	10.8	Standing	Unchanged
58	Existing	8.3	Sitting	-	11.9	Standing	-
	Future	10.5	Standing	Reduced	13.1	Standing	Unchanged
59	Existing	7.5	Sitting	-	10.7	Standing	-
	Future	9.9	Sitting	Unchanged	12.8	Standing	Unchanged
60	Existing	8.4	Sitting	-	11.6	Standing	-
	Future	8.3	Sitting	Unchanged	11.2	Standing	Unchanged
61	Existing	8.7	Sitting	-	12.3	Standing	-
	Future	7.2	Sitting	Unchanged	9.5	Sitting	Improved
62	Existing	8.9	Sitting	-	12.9	Standing	-
	Future	11.9	Standing	Reduced	15.7	Walking	Reduced







APPENDIX C

WIND TUNNEL SIMULATION OF THE NATURAL WIND

WIND TUNNEL SIMULATION OF THE NATURAL WIND

Wind flowing over the surface of the earth develops a boundary layer due to the drag produced by surface features such as vegetation and man-made structures. Within this boundary layer, the mean wind speed varies from zero at the surface to the gradient wind speed at the top of the layer. The height of the top of the boundary layer is referred to as the gradient height, above which the velocity remains more-or-less constant for a given synoptic weather system. The mean wind speed is taken to be the average value over one hour. Superimposed on the mean wind speed are fluctuating (or turbulent) components in the longitudinal (i.e. along wind), vertical and lateral directions. Although turbulence varies according to the roughness of the surface, the turbulence level generally increases from nearly zero (smooth flow) at gradient height to maximum values near the ground. While for a calm ocean the maximum could be 20%, the maximum for a very rough surface such as the center of a city could be 100%, or equal to the local mean wind speed. The height of the boundary layer varies in time and over different terrain roughness within the range of 400 metres (m) to 600 m.

Simulating real wind behaviour in a wind tunnel requires simulating the variation of mean wind speed with height, simulating the turbulence intensity, and matching the typical length scales of turbulence. It is the ratio between wind tunnel turbulence length scales and turbulence scales in the atmosphere that determines the geometric scales that models can assume in a wind tunnel. Hence, when a 1:200 scale model is quoted, this implies that the turbulence scales in the wind tunnel and the atmosphere have the same ratios. Some flexibility in this requirement has been shown to produce reasonable wind tunnel predictions compared to full scale. In model scale the mean and turbulence characteristics of the wind are obtained with the use of spires at one end of the tunnel and roughness elements along the floor of the tunnel. The fan is located at the model end and wind is pulled over the spires, roughness elements and model. It has been found that, to a good approximation, the mean wind profile can be represented by a power law relation, shown below, giving height above ground versus wind speed.

$$U = U_g \left(\frac{Z}{Z_g} \right)^{\alpha}$$

Where; $\boldsymbol{U}$ = mean wind speed, $\boldsymbol{U_g}$ = gradient wind speed, $\boldsymbol{Z}$ = height above ground, $\boldsymbol{Z_g}$ = depth of the boundary layer (gradient height) and α is the power law exponent.

Figure B1 on the following page plots three velocity profiles for open country, and suburban and urban exposures.

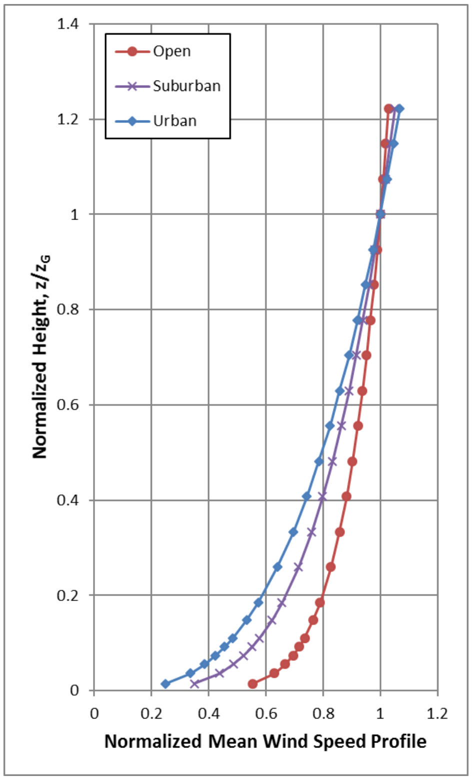
The exponent α varies according to the type of upwind terrain; α ranges from 0.14 for open country to 0.33 for an urban exposure. Figure C2 illustrates the theoretical variation of turbulence for open country, suburban and urban exposures.

The integral length scale of turbulence can be thought of as an average size of gust in the atmosphere. Although it varies with height and ground roughness, it has been found to generally be in the range of 100 m to 200 m in the upper half of the boundary layer. Thus, for a 1:300 scale, the model value should be between 1/3 and 2/3 of a metre. Integral length scales are derived from power spectra, which describe the energy content of wind as a function of frequency. There are several ways of determining integral length scales of turbulence. One way is by comparison of a measured power spectrum in model scale to a non-dimensional theoretical spectrum such as the Davenport spectrum of longitudinal turbulence. Using the Davenport spectrum, which agrees well with full-scale spectra, one can estimate the integral scale by plotting the theoretical spectrum with varying L until it matches as closely as possible the measured spectrum:

$$f \times S(f) = \frac{\dfrac{4(Lf)^2}{U_{10}{}^2}}{\left[1 + \dfrac{4(Lf)^2}{U_{10}{}^2}\right]^{\frac{4}{3}}}$$

Where, f is frequency, S(f) is the spectrum value at frequency f, U10 is the wind speed 10 m above ground level, and L is the characteristic length of turbulence.

Once the wind simulation is correct, the model, constructed to a suitable scale, is installed at the center of the working section of the wind tunnel. Different wind directions are represented by rotating the model to align with the wind tunnel center-line axis.



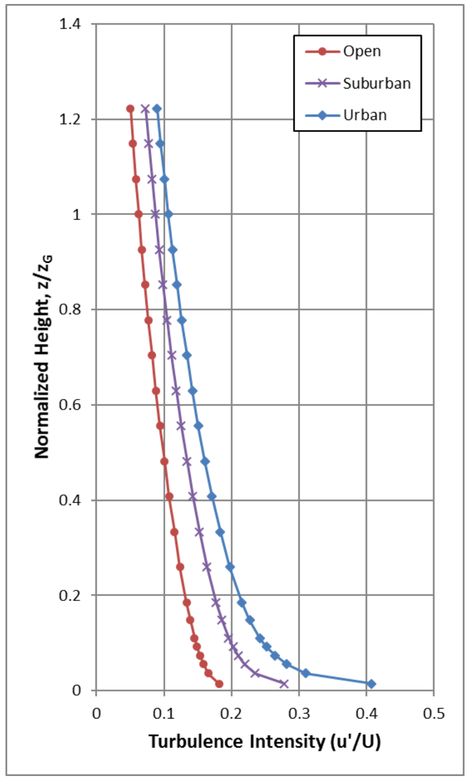


FIGURE C1 (LEFT): MEAN WIND SPEED PROFILES;
FIGURE C2 (RIGHT): TURBULENCE INTENSITY PROFILES

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APPENDIX D

PEDESTRIAN LEVEL WIND MEASUREMENT METHODOLOGY

PEDESTRIAN LEVEL WIND MEASUREMENT METHODOLOGY

Pedestrian level wind studies are performed in a wind tunnel on a physical model of the study buildings at a suitable scale. Instantaneous wind speed measurements are recorded at a model height corresponding to 1.5 m full scale using either a hot wire anemometer or a pressure-based transducer. Measurements are performed at any number of locations on the model and usually for 36 wind directions. For each wind direction, the roughness of the upwind terrain is matched in the wind tunnel to generate the correct mean and turbulent wind profiles approaching the model.

The hot wire anemometer is an instrument consisting of a thin metallic wire conducting an electric current. It is an omni-directional device equally sensitive to wind approaching from any direction in the horizontal plane. By compensating for the cooling effect of wind flowing over the wire, the associated electronics produce an analog voltage signal that can be calibrated against velocity of the air stream. For all measurements, the wire is oriented vertically so as to be sensitive to wind approaching from all directions in a horizontal plane.

The pressure sensor is a small cylindrical device that measures instantaneous pressure differences over a small area. The sensor is connected via tubing to a transducer that translates the pressure to a voltage signal that is recorded by computer. With appropriately designed tubing, the sensor is sensitive to a suitable range of fluctuating velocities.

For a given wind direction and location on the model, a time history of the wind speed is recorded for a period of time equal to one hour in full-scale. The analog signal produced by the hot wire or pressure sensor is digitized at a rate of 400 samples per second. A sample recording for several seconds is illustrated in Figure D1. This data is analyzed to extract the mean, root-mean-square (rms) and the peak of the signal. The peak value, or gust wind speed, is formed by averaging a number of peaks obtained from sub-intervals of the sampling period. The mean and gust speeds are then normalized by the wind tunnel gradient wind speed, which is the speed at the top of the model boundary layer, to obtain mean and gust ratios. At each location, the measurements are repeated for 36 wind directions to produce normalized polar plots, which will be provided upon request.

In order to determine the duration of various wind speeds at full scale for a given measurement location the gust ratios are combined with a statistical (mathematical) model of the wind climate for the project site. This mathematical model is based on hourly wind data obtained from one or more meteorological stations (usually airports) close to the project location. The probability model used to represent the data is the Weibull distribution expressed as:

$$P\left(>U_g\right) = A_\theta \bullet \exp\left[\left(-\frac{U_g}{C\theta}\right)^{K\theta}\right]$$

Where,

P (> U_g) is the probability, fraction of time, that the gradient wind speed ***U_g*** is exceeded; ***θ*** is the wind direction measured clockwise from true north, ***A***, ***C***, ***K*** are the Weibull coefficients, (Units: A - dimensionless, C - wind speed units [km/h] for instance, K - dimensionless). ***A_θ*** is the fraction of time wind blows from a 10° sector centered on ***θ***.

Analysis of the hourly wind data recorded for a length of time, on the order of 10 to 30 years, yields the ***A_θ, C_θ*** and ***K_θ*** values. The probability of exceeding a chosen wind speed level, say 20 km/h, at sensor *N* is given by the following expression:

$$P_N(>20) = \Sigma_\theta P\left[\frac{(>20)}{\left(\frac{U_N}{U_g}\right)}\right]$$

$$\boldsymbol{P_N\,(>20) \quad = \quad \Sigma_\theta P\,\{>20/(U_N/Ug)\}}$$

Where, ***U_N/U_g*** is the gust velocity ratios, where the summation is taken over all 36 wind directions at 10° intervals.

If there are significant seasonal variations in the weather data, as determined by inspection of the $\boldsymbol{C_\theta}$ and $\boldsymbol{K_\theta}$ values, then the analysis is performed separately for two or more times corresponding to the groupings of seasonal wind data. Wind speed levels of interest for predicting pedestrian comfort are based on the comfort guidelines chosen to represent various pedestrian activity levels as discussed in the main text.

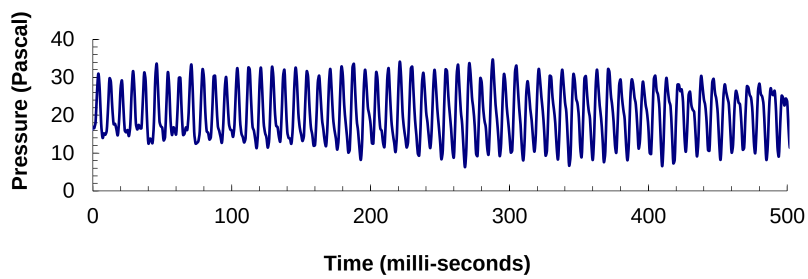

FIGURE D1: TIME VERSUS VELOCITY TRACE FOR A TYPICAL WIND SENSOR

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